Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

VOLUME L NUMBER 6

BOTANICAL GAZETTE

DECEMBER 1910

THE PTEROPSIDA[1]

EDWARD C. JEFFREY

(WITH PLATE XIII)

Two years ago, I published a reply to the various criticisms which had been made from time to time of the great group of vascular plants defined as Lycopsida. At that time a promise was made that the attacks, neither few nor unimportant, leveled at the pendent and corresponding phylum Pteropsida, would likewise be met. In the interval my time has been very much taken up with investigations on the higher seed plants, and it has heretofore been impossible to carry out the intention then expressed. The delay, however, is rather an advantage than otherwise, for it has enabled the opposition to the conceptions connected with the Pteropsida to crystallize and clarify, which materially simplifies the task of criticism. Moreover, in the past two years we have seen venerable but no longer useful morphological doctrines go by the board. Their disappearance is of importance in the present connection, because they have been haled into court in the present discussion.

The validity of the Pteropsida, as a natural phylum, may apparently now be taken as settled, since the group as defined by the present writer has been adopted by a number of botanists, whose knowledge, at once profound and extensive, of living and extinct vascular plants makes their opinion of the greatest weight. There appears accordingly to be no serious opposition at the present time to the conception that all those Vasculares which are characterized by palingenetically large leaves and dorsal or abaxial sporangia are in reality so united by a common plexus of origin that they may be with advantage mustered under a common appelation.

---

[1] Contributions from the Phanerogamic Laboratories of Harvard University, no. 30.

Although the standing of the Pteropsida as a large natural phylum of plants now appears to be on a firm footing, the important question of the morphology of the central cylinder or stele of vascular plants is still the subject of much controversy, and the English school of morphologists, led by Dr. D. H. SCOTT, who is himself a host, has attacked the present writer's position with great vigor. The Pteropsida certainly are the appropriate battle ground for the decision of the fundamental morphological question of the internal morphology of the stem, since, unlike the Lycopsida, they are still in full vigor, while they share with the latter phylum the advantage of a very extended history. The most important line of attack is in connection with the morphological status of the pith, which the present writer regards as external tissue included by the stele in the course of evolution. The English anatomists, on the contrary, regard the pith as in all cases a specially differentiated central portion of the fibrovascular tissue itself. Of late, however, the extremity of the English view appears to be modified somewhat by the admission that in certain instances the pith may be derived from outside the stele. Another less important and not generally adopted criticism of the author's views is to the effect that the megaphyllous or large-leaved habit is not a primitive one for the Pteropsida. This criticism has been put forward by only a few of the English anatomists, and appears to have been effectually answered by two recent American writers on the subject.

The lapse of time has made the task of replying to criticisms against the extrastelar origin of the pith a much easier one. The growing-point hypothesis, which has been applied by STRASBURGER to the elucidation of the morphology of the pith, has been recently rejected by a number of morphologists in Europe and America.[2] The interpretation of the mature structure of the organs of the higher plants in reference to the so-called apical meristems has long dominated morphology of a certain type, although its validity in relation to the histological structure of stems, roots, etc., has never been admitted by such distinguished anatomists as DEBARY and VAN TIEGHEM. It has not been any gain to anatomy that STRASBURGER, a morphologist of the reproductive structures and the cell, should have forced the growing-point hypothesis into the anatomical field in his one important contribution to vegetative histology.[3] It is more unfortunate that his views have been adopted and elaborated by those who cultivate anatomy in England. With the overthrow of the hypothesis in regard to the morphological value of apical meristems, the views of the English anatomists, who have built on this uncertain foundation, have lost a fundamental support. That the application of the hypothesis of apical meristems to anatomical facts leads to hopeless contradictions and logical absurdities the present writer has shown in his article cited above. It appears to be unnecessary to repeat these arguments here.

---

[2] JEFFREY, E. C., Morphology and phylogeny. Science N.S. **23**:291. 1906.

BOWER, F. O., The origin of a land flora, chaps. xiv and xv. London. 1908.

COULTER, J. M., Vascular anatomy and the reproductive structures. Amer. Nat. **43**:219–230. 1909.

It must be admitted that the English view, propounded by Dr. SCOTT in a review of the present author's investigations on the stele (*New Phytol.* 1902) and repeated with conviction by nearly all subsequent English writers on anatomical themes, has an air of probability in its favor, in spite of the fact that it can no longer summon to its support the hypothesis of the apical meristems. It seems prima facie improbable that the fibrovascular structures of the stem should be able to surround or contain tissues which primitively lie outside. Moreover, the holders of the view in regard to the stelar origin of the pith have the advantage that their opponents in a measure face the logical impossibility of proving a negative. Although it is not possible to prove in all cases that the pith may be derived from outside the stele, it is fortunately only necessary to demonstrate this in a few instances, in order to invalidate the position of those who claim that the pith is differentiated from the substance of the stele itself.

Professor GWYNNE-VAUGHAN among English anatomists is the one who has shown the greatest openness of mind in regard to the origin of stelar structures, for, unlike most of his countrymen, he has always been willing to admit that there is some evidence as to the extrastelar origin of the pith in certain instances. To him belongs the credit of having called attention to the fact that in certain of the ferns, structures which are unquestionably extrastelar in their origin may penetrate the central cylinder of the stem.[4] Fig. 1 of the plate accompanying this article shows a transverse section of the stem of *Onoclea* (*Struthiopteris*) *germanica.* The stem is very irregular in outline on account of the crowded leaf bases attached to its surface. The leaf bases, actual or potential, are distinguishable by the fact that they have a double fibrovascular bundle. In the substance of the stem lie a number of cavities, situated for the most part within the boundaries of the central cylinder, as determined by a line drawn external to its bundles. These cavities are more or less occupied with a filmy substance representing the ramental covering of the epidermis. By inspection of the figure it can be clearly made out that the cavities plugged with *ramentum,* occurring in the substance of the pith, are derived from outside, and represent ingrowths of the external epidermis, including the outside air. Fig. 2 represents a part of a similar section somewhat more highly magnified. On the left may be seen the communication of the medullary pocket with the exterior surface of the stem. It is an axiom with the greater number of the English anatomists, that if pockets or apparent ingrowths of tissues, normally extrastelar, occur within the central cylinder, these are not what they appear to be, namely, incursions of extrastelar tissues into the substance of the stele, but, on the contrary, are merely portions of the stele which have been so transformed as to resemble tissues of the cortex. In the case supplied by our two figures we have a logical *reductio ad absurdum* of the usual English view, for here we have not only the external hairy covering of the stem but even the outside air making their way into the innermost sanctity of the stele. Even the most convinced adherent of the stelar origin of the pith must admit that in this case structures which are quite outside the stele are able to make their way into it. If it is once conceded that such clearly extrastelar substances as ramentum-covered epidermis and the free external atmosphere are able to make their way into the interior of the stele, there appears to be little ground for questioning that the cortex and its internal boundary, the endodermis, may penetrate the same *sanctum sanctorum.* In the present defunct condition of the growing-point hypothesis, it seems clear, in view of existence of such facts as those illustrated in the two figures just described, that the dogma of the stelar origin of the pith rests on an extremely weak foundation.

---

[3] STRASBURGER, ED., Bau u. Verrichtungen d. Leitungsbahnen. Hist. Beitr. 3:1891.

---

[4] GWYNNE-VAUGHAN, D. T., On the possible existence of a fern stem having the form of a lattice-work tube. New Phytol. 4:no. 9. 1905.

It is admitted further, even by those who are most extreme in their support of the view that the pith is always of stelar origin, that, although the central cylinder of the stem cannot include within itself the outlying tissues of the cortex, this possibility exists in the case of the leaf trace. Mr. BOODLE, the most logical and consistent of the younger English anatomists, and one whose contributions, together with those of Dr. D. T. GWYNNE-VAUGHAN, comprise the most important data on the anatomy of ferns which have recently appeared in England, not long since published an article on certain species of *Gleichenia.*[5] He here states that "the nearly circular or subcordiform petiolar bundle of *Eugleichenia* may be held to be derived from the horseshoe-shaped bundle of the *Mertensia* type by contraction, and by the fusion of the free ends of the horseshoe, *the sclerenchymatous cortex in the concavity of the latter thus becoming inclosed*, or at a higher level suppressed"! The present writer has italicized the significant part of the quotation. It is apparent that Mr. BOODLE admits that the foliar trace may include cortical tissue. If such an admission is made in the case of the Gleicheniaceae, it cannot fail of application to the petiolar structures of other families of ferns. Let us take as an example, among many others, the case of the Marattiaceae. In fig. 3 is represented the vascular system of the base of one of the large pinnules of *Angiopteris evecta.* The bundles are arranged in a horseshoe-shaped manner, with the two large bundles terminating the arms of the horseshoe turned inward and downward.

---

[5] BOODLE, L. A., and HILEY, W. E., On the vascular structure of some species of *Gleichenia.* Annals of Botany **23**:419–432. *pl. 29.* 1909.

Within this horseshoe-shaped cordon of bundles is inclosed a mass of cortical tissue, which to all intents is a pith. Fig. 4 represents a cross-section of the bundle system of the pinnular petiole at a higher level, where, as in *Gleichenia* cited above, the edges of the horseshoe have fused together. It is clear that as a result of this fusion we have a mass of included cortical tissue entirely surrounded by bundles, in other words a condition which the present writer has hypothetically considered to exist in the case of the central cylinder of the stem, where it contains a pith. On the right of the fused horseshoe-shaped complex of bundles two small strands are seen passing off to supply a pinnule of the second order, leaving a gap precisely like that found in connection with the departing leaf traces of the stem or main axis. It is impossible to disregard this obvious resemblance of all the structures in the petiole under discussion to those found in the stem. It is at once suggested that the interpretation of the two sets of facts must be the same, and that if, as is admitted, the petiolar strands are able to inclose tissues of the cortex, there is no reason to question that the same process of the inclusion of fundamental tissues by the fibrovascular system may take place in the stem. This view of the matter gathers force from the hypothesis, which has won favor in England and on the continent, that the leaf of ferns represents only a modified branch. If this view of the morphology of filicinean leaves is adopted, it makes the study of that organ of great use in throwing light on the conditions found in the stem, especially as the leaf by its well-recognized conservatism will supply us with evolutionary stages which have become obsolete in the stem proper.

Fig. 5 represents a cross-section of the entire rachis of *Marattia alata* at a point where the petiolar bundles have formed a closed system by the fusion of the originally free ends of the horseshoe-shaped complex. Here we see precisely the same conditions as are found in the case of *Angiopteris evecta*. Fig. 6 shows the same leaf axis at a higher point, where a vascular supply for a secondary axis is being given off. This plane of section is of special interest because the large medullary bundle formed from the fusion of the two margins of the original horseshoe-shaped complex is functioning in the same way as is commonly found to be the case with the medullary strands of the stem, namely as a reparatory strand to help fill up the leaf gap above the point of departure of the traces. It is clear from what has been stated in the case of *Marattia alata*, just described, that the leaf may develop a vascular system resembling in a detailed manner that found in the case of siphonostelic stems. It seems eminently a sound conclusion to infer as a consequence, since the fundamental tissue of the cortex may readily be included in the fibrovascular system of the leaf trace, that a similar condition may also occur in the stem.

Only two examples have been chosen for illustration of the occurrence of siphonostelic leaf traces, but the genus *Danaea* among the Marattiaceae presents parallel conditions to *Angiopteris* and *Marattia*. Among the other families of ferns the phenomenon is frequently represented. A notable and common case is that of *Pteris aquilina*. Here the sides of the original channel-shaped leaf strand become strongly pushed in, and the fusion takes place so that the joining bundles constituting the margins of the fibrovascular complex of the leaf lie above and outside the siphonostelic lower part of the leaf system. The branches given off to the main ramifications of the leaf are derived from the lateral margins of the siphonostelic region, but in passing off receive a subtending strand from the large upper fused bundle, which lies on the outside of the stelar tube of the leaf axis. The siphonostelic condition in the foliar supply is not confined to the ferns, but is likewise of very frequent occurrence in the angiosperms, where it is susceptible of a similar morphological interpretation. In the case of certain dicotyledons, moreover, diverticula of the epidermis, lined with a hairy covering, make their way into the cavity of the pith of the leaf stalk, showing that here too there is no question of the possibility of extravascular tissues being included within the complex of bundles. It may be further stated that there appears to be no clear distinction between the condition where the cortical fundamental tissues become deeply embayed in the fibrovascular system of the leaf, and where an actual siphonostelic condition results from the fusion of the marginal bundles of the foliar complex. Accordingly it appears strictly logical to include the deeply infolded petiolar supply of the cycads in our argument. Since the leaf traces of this group originate on the opposite side of the stem from that on which they pass out into their corresponding leaf, it would be necessary to assume that each half of the leaf supply carried with it its own peculiar portion of the medullary parenchyma, and that the fractions were accurately joined with one another in the leaf base, to the exclusion of the fundamental tissue of the cortex, if we were to accept the idea that the fibrovascular tissues are in general unable to embay or include portions of the fundamental tissues of the cortex. This seems much too improbable a supposition to be seriously entertained.

It appears evident, since the stelar system of the stem in the case of certain of the lower Pteropsida, for example, species of *Onoclea*, *Cystopteris*, *Aneimia*, etc., is able to include tissues and substances which are beyond question extrastelar in their origin, that no difficulty arises in regarding the pith present within the siphonostelic central cylinder of the lower (as well as the higher) Pteropsida as morphologically equivalent with the fundamental tissue of the cortex, with which it is often continuous through the gaps in the stelar walls resulting from the exit of the vascular supply of leaves and branches. A further argument in favor of this view is the frequent textural similarity between pith and cortex, even where the former as the result of upward evolutionary changes is no longer continuous with the fundamental tissue without the stele. It follows equally that the morphological doctrine for which STRASBURGER is responsible, and which has been carried to its logical conclusion and *reductio ad absurdum* by the English anatomists, namely, that the criteria of the morphological status of plant tissues are to be derived from a study of the growing point of the mature organ rather than from comparative anatomical considerations and particularly from a study of the seedling, falls to the ground.

It is now possible to consider with advantage the alleged primitive absence of foliar gaps in the Pteropsida, which has recently been asserted by GWYNNE-VAUGHAN in connection with studies on fossil representatives of the Osmundaceae. In the genus *Thamnopteris*, this author has found the center of the stele to be occupied by a large mass of short tracheids, which he has interpreted as a pith of stelar origin. To state that a central mass of tissue, which according to the author's own admission is entirely tracheary, is the forerunner of the pith, and proves the origin of the latter from tissues of the stele, is apparently a clear case of begging the question. The example of another fossil osmundaceous genus, *Zalesskia*, which has also been brought into court by GWYNNE-VAUGHAN, is equally inconclusive, since the central tissues in the two species of this genus described are in a very bad condition of preservation. Naturally enough, in these obviously protostelic representatives of the Osmundaceae, this author found no evidence of the presence of foliar gaps. A much stronger argument in favor of his view is furnished by the fossil genus *Osmundites Dunlopi*. Here in sections of the very badly preserved stem it was impossible to distinguish clearly any foliar gaps. GWYNNE-VAUGHAN assumes that the obviously much contracted central cylinder of his *Osmundites Dunlopi* represents the primitive conditions in the Osmundaceae, and shows that foliar gaps were originally absent in this family. It is not less reasonable to suppose that the nearly contemporary *Osmundites skidgatensis* from the Lower Cretaceous of the western coast of the Dominion of Canada, in which the foliar gaps are very large and in which the pith very clearly communicates with the histologically strikingly similar tissues of the cortex, in reality represents the primitive condition for the Osmundaceae. All that the fossil evidence enables us to state regarding the Osmundaceae, which constitutes the only evidence for GWYNNE-VAUGHAN'S hypothesis of the original absence of foliar gaps in the fern series, is that the Osmundaceae varied more in structure in both directions during the Mesozoic than they do at the present time, in other words they presented a more generalized condition.

The evidence from the comparative anatomical and developmental standpoints is, on the contrary, clearly all in one direction. Mr. SINNOTT in a recent article[6] has shown that in the genus *Todea*, especially in the filmy subgenus *Leptopteris*, there is frequently an apparent absence of foliar gaps, but that in all the species which he studied in serial sections a gap was really present, although in a single section it might appear to be absent. Moreover, it was shown by this author that in the case of the horseshoe-shaped stele of the leaf in species of *Osmunda* and *Todea*, the passing off of the pinnular traces always left clear gaps in its wall. Moreover, both Mr. SINNOTT and Professor FAULL[7] have made it quite clear that the hypothesis of GWYNNE-VAUGHAN as to the primitive absence of foliar gaps in the Osmundaceae receives no support whatever from a consideration of the anatomy of the seedling of living species. Consequently, we may say of the hypothesis advocated by GWYNNE-VAUGHAN that it is not definitely confirmed by the fossil evidence, and that all the evidence derived from the consideration of the anatomy of the stem, leaf, and seedling of living species is entirely against his view. It may consequently be stated with confidence that at the present time there is no valid proof in favor of the original absence of foliar gaps in the Osmundaceae.

---

[6] SINNOTT, E. W., Foliar gaps in the Osmundaceae. Annals of Botany **24**:107–118. *pls. 11, 12.* 1910.

The English school of anatomists has been well advised in making its stand upon the stelar origin of the pith as opposed to its derivation by the inclusion of extrastelar fundamental tissue within the central cylinder, for if that view is once overthrown, a number of other conceptions commonly held in England fall with it to the ground. If it be clear that the pith is originally an inclusion of the fundamental tissues within the central cylinder, certain interesting conclusions immediately follow. One of the most important and far-reaching generalizations of modern plant anatomy, and one which receives the fullest support from the considerations of all the main groups of vascular plants, is that the foliar strand perpetuates the original condition of the wall of the stelar tube. There is distinct evidence in the case of the Osmundaceae, Ophioglossaceae, Lyginodendreae, Equisetales, etc., that the central cylinder of the stem was once composed of concentric fibrovascular bundles, since bundles of this type persist in the leaf trace or sporophyll trace of these various groups. This inevitably follows if it is admitted, as apparently it must be from the application of sound logic to the known facts, that the pith in these families or orders is morphologically included fundamental tissue.

---

[7] FAULL, J. H., The stele of *Osmunda cinnamomea*. Trans. Canad. Inst. 8:515–534. 1909.

On the basis of conclusions drawn from the leaf trace in existing pteridophytic groups, we must regard the concentric as the primitive type of fibrovascular bundle. This view of the matter is strengthened by the fact that the concentric bundle is characteristic of the phylogenetically older representatives of the Pteropsida. In the case of the Lycopsida, unfortunately, the evidence is very defective, since this phylum reached its culmination in the remote past and is now almost extinct. The English view of the matter is diametrically opposite, namely, that the collateral bundle is more ancient and that the concentric type has been derived from it. It has been cited in favor of this view, originally by Dr. SCOTT and afterward by nearly all the younger English anatomists, that no evidence is forthcoming in favor of the superior age of the concentric type of bundle in the case of the seedling of the ferns which have collateral stem bundles in the adult. This statement appears to be entirely fallacious. In the first place it would be just as reasonable to assume that centripetal or cryptogamic xylem was not originally present in the stem bundles of our existing gymnosperms, because forsooth it has never been found in the seedling stem. The present writer entirely agrees with the English anatomists in the conviction that centripetal xylem was once well developed in the stem of the ancestors of the living gymnosperms, but this conclusion rests on the persistence of this type of xylem in the leaf trace of forms actually living or their immediate ancestors. On the same basis of argument, concentric bundles were originally present in the stems of those few ferns which today show a collateral condition in their cauline system, for here, as in the gymnosperms, the structure of the leaf affords evidence which is no longer supplied by the seedling. Moreover, if the collateral type of bundle is really primitive for the fern series as a whole, one would expect to find some evidence of its presence in the seedlings of the extremely numerous modern ferns which are characterized by the presence of concentric bundles both in their stems and leaves. Although a great deal of attention has been devoted by the younger English anatomists to hunting for such evidence in fern seedlings, success has not crowned their efforts. Moreover, if the collateral type of bundle really be primitive for the existing ferns, we should expect to find this condition present in the bases of their foliar organs. It follows, from all the considerations mentioned above, that the absence of the concentric condition in the seedlings of the comparatively few existing ferns showing collateral organization in their adult cauline system constitutes no valid argument against the primitiveness of the concentric bundle for the stem of these and of ferns in general. The evidence considered in connection with the extremely sound and satisfactory generalizations concerning the conservative character of the leaf trace, to which the English anatomists have contributed so honorable a share, is entirely in favor of the concentric as the primitive type of cauline bundle in the fern series.

It follows that none of the recent work overthrows the generalizations put forward in the writer's earlier memoirs as to the phylogeny of the stem in the vascular series. It now in fact appears much more clearly than formerly that the primitive condition of the vascular system in both stem and leaf in the Vasculares as a whole was what the present writer has designated protostelic, that is, a condition in which the fibrovascular tissues harbored no pith. Following this condition was one in which the fibrovascular system became transformed, especially in the more progressive stem, into a stelar tube lined both internally and externally with phloem and endodermis. In the process of time the internal phloem became degenerate, probably on account both of the absence of direct relation to the leaves and of the appearance of secondary growth, advantageously localized ultimately on the outer surface of the stele. The internal endodermis more slowly followed the internal phloem into oblivion, and is often found at the present time in the young individual where it is absent in the adult (Ophioglossaceae, Equisetaceae, Ranunculaceae). The pith must in all cases be regarded as a derivative of the cortex, which has become more or less completely sequestered within the stele. The tubular stele may with propriety and accuracy continue to bear the designation siphonostelic, a term moreover which, in addition to having an apparently wider and truer significance than the English term solenostelic, holds the claim of priority.

NOTE ON THE LYCOPSIDA.—In the second edition of his admirable *Studies in fossil botany*, Dr. SCOTT adopts without question the present writer's phylum Pteropsida. He also adopts the designation Lycopsida, but confines its application to the Lycopodiales, living and extinct. For the remaining groups included in the present writer's Lycopsida, he proposes the name Sphenopsida, since he regards the Equisetales, Psilotales, and Sphenophyllales as not properly microphyllous, or to be included in the same phylum as the Lycopodiales. This view does not appear to be well founded, since the Equisetales and Psilotales are on anatomical grounds clearly and unquestionably microphyllous and likewise ventrisporangiate. There is no anatomical evidence as to the microphyllous character of the Sphenophyllales, since their central cylinder is protostelic. They resemble the two series mentioned, however, in being ventrisporangiate. The writer is of the opinion that the forking and arrangement of the fibrovascular strands in the blade of the leaf affords an unreliable criterion as to affinities, since if we considered the forking leaf trace rather than the relation of the foliar strands to the stele of the stem, it would be necessary to include certain Sigilliarieae with the Lycopsida in the sense of Dr. SCOTT and others with his Sphenopsida. A forking leaf trace and even a large leaf blade may occur in the lycopsid series, but neither of these is a palingenetic feature, as is clearly shown by the relation of the leaf trace to the central cylinder of the stem. There appears, in view of the considerations just described, no reason of sufficient weight for excluding the Equisetales, Psilotales, and Sphenophyllales from the phylum Lycopsida, since they possess all the essential characters of this great group. At best these three series can be aggregated only as a subgroup under the main heading Lycopsida.

NOTE.—It is a fact, apparently not without significance, that the various recent English writers, who are impelled to disagree with the present author's views as to the absence of foliar gaps in the Equisetales, have not made any reply to the seemingly unanswerable arguments in favor of these views, but have contented themselves with the mere reiteration of a dissentient opinion.

The conviction is continually repeated, in recent English publications bearing on this subject, that the gaps above the leaf traces in the modern Equisetales, but separated from their supposedly corresponding traces by the whole thickness of the so-called nodal wood, are in reality foliar gaps. An insuperable difficulty in this view, in addition to the very important anatomical ones cited by the present writer, is the fact that in both paleozoic and mesozoic representatives of the Equisetales the supposed foliar gaps are sometimes twice as numerous as the traces. It follows, of course, that some of the putative foliar gaps were not in reality leaf gaps in the older representatives of the Equisetales. This state of affairs, brought into strong prominence by recent Swedish investigations on mesozoic Equisetales, seems to furnish the necessary *coup de grace* to the views tenaciously held in England.

SUMMARY

1. The Pteropsida represent a great natural phylum of vascular plants characterized by dorsisporangiate sporophylls and by palingenetically large leaves, as inferred from their anatomical relations.

2. The pith of the Vasculares, in all cases where definite evidence is available, is an inclusion of the fundamental tissues of the cortex on the part of the stele.

3. The concentric type of tubular central cylinder is more ancient than the collateral and antedates the latter, as is shown by the persistence of the concentric condition in many leaf traces, where it has become obsolete in the stem.

4. So far as the primary bundle system of the Vasculares is concerned, they present a reduction series, in which the ferns and lower gymnosperms (Archigymnospermae) represent the earlier and more complex stages, and the higher gymnosperms (Metagymnospermae) and dicotyledons the phases which are more recent and more simplified.

HARVARD UNIVERSITY
CAMBRIDGE, MASS.

EXPLANATION OF PLATE XIII

FIG. 1.—Transverse section of the stem of *Onoclea Struthiopteris;* ×5.

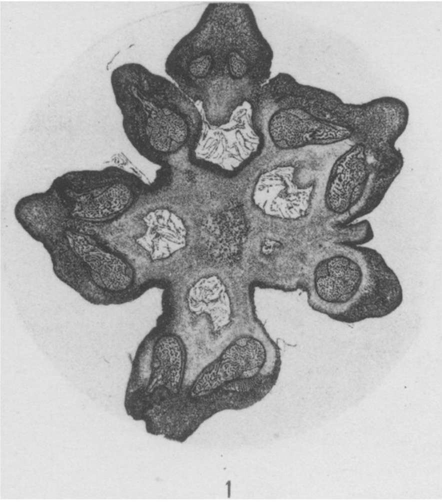
FIG. 2.—Transverse section of a part of the stem of the same species; ×10.

FIG. 3.—Transverse section of the base of the pinnular axis of *Angiopteris evecta;* ×10.

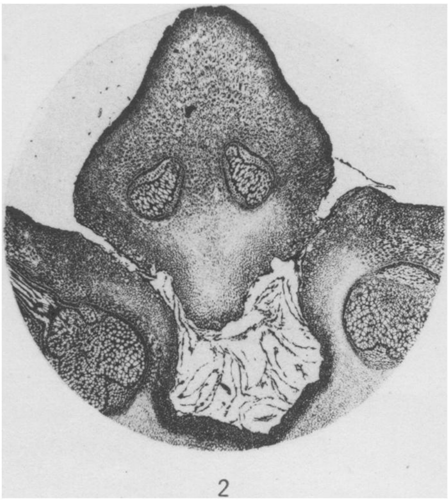
FIG. 4.—Transverse section of the same at a higher level, showing the fusion of the marginal bundles of the foliar system; ×10.

FIG. 5.—Transverse section of the rachis of *Marattia alata;* ×10.

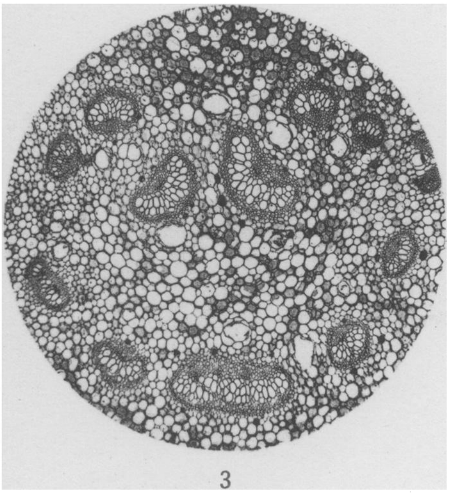
FIG. 6.—The same, showing the exit of the vascular supply of a secondary axis; ×10.



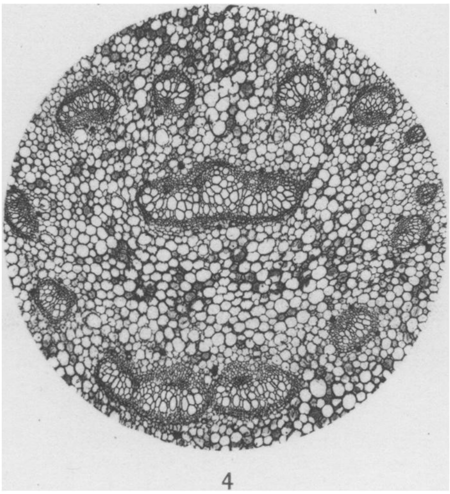
1



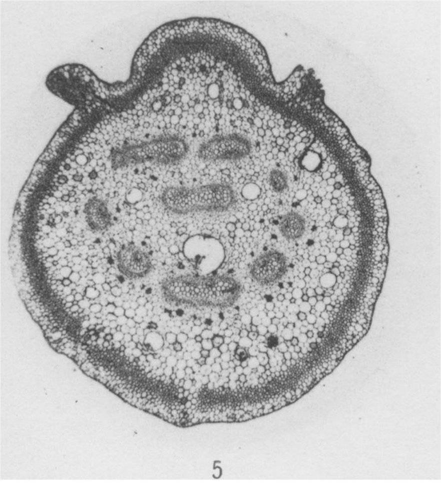
2



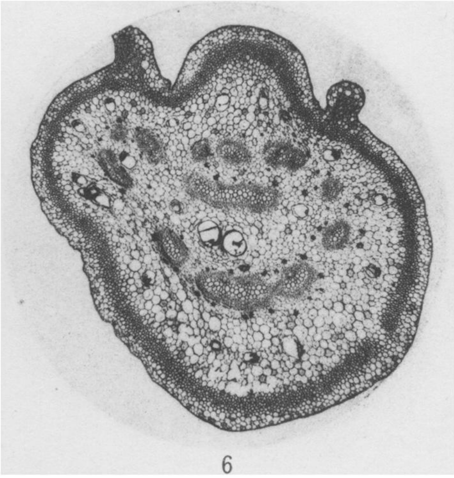
3



4



5



6

JEFFREY on PTEROPSIDA